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ARE INTERNET GROCERY MARKETS MORE EFFICIENT? *

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Abstract

This paper features describes online grocery markets and analyzes its features that might make these markets more efficient economically. Price data were gathered for online and traditional retailers for a variety of products over a number of weeks in order to test these implications. Analysis of these prices indicate differences between Internet only retailers and hybrid retailers. While hybrid retailers appeared much like traditional supermarkets, Internet only retailers seemed to be at a disadvantage commercially.

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I. Introduction

E-commerce is thought to better facilitate consumer decision making than traditional markets. The increased amount of product information available to consumers could lead to better alignment between consumer preferences and products selected. Moreover, the greater ease with which consumers can compare products across retailers is thought to mitigate some consumer switching costs. To the extent that these effects are realized, Internet retailing could lead to greater market efficiency and, thus, consumer and total welfare (Brynjolfsson and Smith, 1999). In contrast, for most products, E-commerce suffers from high distribution costs. Online shoppers bear a pecuniary cost for delivery of the product. In traditional markets, consumers bear a non-pecuniary cost from transporting the product to the consumer's home. Online shopping becomes less attractive for products that suffer from market based delivery service, e.g. perishables, or for people with lower values of their own time.

For some products, namely groceries, product selection and delivery are jointly produced in a grocery store visit. While online shopping may facilitate product selection, consumers may not benefit from a large reduction in actual visits to supermarkets. Consumers who purchase for immediate consumption or who will purchase some items at the traditional retailer may not experience any reduction in total delivery costs. To mitigate these costs, online grocery shoppers are likely to make larger, regularly scheduled purchases and, in doing so, make human capital investments specific to a particular Internet retailer. If these human capital investments are large, consumers will still face substantial switching costs online. In this case, Internet grocery markets may not be much more efficient that traditional grocery markets.

This general proposition is investigated through a series of tests between prices charged by

online and traditional retailers. Price data for two dozen items sold at thirty-two retailers in eight medium sized Illinois and Indiana cities and comparable items sold over the Internet were collected. Retailers in each town were sampled every four weeks. The resulting dataset is particularly suited for testing the effects of consumer search and distribution costs on pricing patterns. This paper specifically investigates whether improvements in market efficiency observed in other Internet based retailing (e.g., books, music, financial services) are likely to be observed for grocery retailing. The data allow comparisons between price levels, price dispersion, and changes in prices.

II. Online Grocery Industry Background

Having only begun in the last four to five years, online retailing is new and online grocery retailing is even newer. Products amenable to early adoption by online retailers included books, music, financial service and travel arrangements. Consumer acceptance of online shopping for a broader array of products has grown more gradually. Online sales of food items have grown even more slowly than sales of most product categories (Lose, Bellman, and Johnson, 1999, Ward, 2000a). Often, consumers consider online shopping to be an extension of catalog shopping (Ward, 2000b). Indeed, there is evidence that higher-end gift food items, such as gourmet foods, chocolates and fruit baskets that are more amenable to catalog sales, have a larger share of total food sold online than they do total food sold from traditional retailers.

Online purchasing of groceries offers some advantages and disadvantages over traditional, brick and mortar (B&M) purchasing. Being computer mediated, all the advantages of computers can be exploited. These include creating and maintaining lists of frequently purchased items for future

purchases, email notification of specials, collection of revealed consumer preference information, and presentation of new items that are complementary to past purchases. Besides the advantages of computer mediation, online shopping can save time for some consumers. Essentially, an online shopper is hiring someone else to pick items from the shelves and deliver them to the shopper's home, tasks that are typically performed by the shopper. At a minimum, online grocery retailing may to fill a niche in catering to individuals with high opportunity cost of time.

Two strategies for selling groceries seem to have emerged. First, B&M supermarket chains are retailing online, as with Schnuck's, or are affiliating with online retailers, as with Jewel/Peapod. A traditional retailer becomes a hybrid retailer by making its in-store items available in its existing geographic markets for order fulfillment and provides delivery of the selected items. Second, new entrants, like NetGrocer, have opened web based grocery stores with a limited selection of products available nationwide that are delivered via an overnight delivery service like FedEx. These strategies have different implications for consumer and producer behavior, and thus for the efficiency of the markets they serve.

Hybrid stores have some advantages over Internet only stores. First, there are few incremental costs of acquiring inventory. No new physical facilities need be built. Second, brand name reputation can be easily extended into the new marketing channel rather than being developed from scratch. Third, the shopping experience can be tailored to be more similar to what grocery shoppers are used to. Human capital developed by customers for say, store brands comparisons and store layouts, can be leveraged into the online channel. Fourth, since they serve local markets, they are better able to offer a full line of products, including perishable items. However, in order to insure against spoilage and

other problems associated with delivery, they often must vertically integrate into delivery services.

Internet only stores have their advantages too. First, because they have no physical retail facilities, the associated costs can be avoided. Warehouses can be optimized for small order fulfillment, lowering long-run operating costs. Second, because they serve larger, usually national, markets, they can take better advantage of economies of scale at a facility. Third, they need not be concerned that the online channel will undermine price discrimination strategies used in different geographic markets (Bailey, 1998).

III. The Internet and Efficiency

Market efficiency refers to both productive efficiency, how cheaply can the product be produced, and allocative efficiency, the extent to which the product is assigned to users who value it most. These concepts are usually identified with the economic welfare measures of producer surplus and consumer surplus. Lowering costs while holding prices constant tends to increase producer surplus. Similarly, lowering price tends to increase consumer surplus. In general, some portion of a firm's cost reductions is usually passed on in the form of lower prices leading to both increased consumer surplus and possibly increased producer surplus. Therefore, price reductions are often indicators of increased market efficiency.[1]

For the most part, these concepts can be expressed through the Lerner index. The Lerner

[1]Note, however, that price reductions could correspond to quality reductions. If so, the decreased willingness to pay could dominate the price reduction, implying a decrease in market efficiency.

index relates a firm's profit-maximizing price-cost margins in an imperfectly competitive market to its demand elasticity as $(P-MC)/P = -1/\theta$. Solving for price, this relation becomes:

$$P = \left(\frac{\theta}{1+\theta} \right) MC. \qquad \textbf{(1)}$$

From equation (1), it can be seen that productive efficiencies that lower marginal costs tend to lower prices and lead to greater market efficiency. Industry changes that increase consumer substitutability between sellers, tend to make firm demand more elastic, θ falls. From equation (1), it can again be seen that this, in turn, lowers the profit-maximizing price and leads to greater allocative efficiency.

Productive efficiencies arise from reductions in fixed costs and not affect marginal costs. In this case, to a first approximation, they do not affect prices. Therefore, fixed cost reductions increase producer surplus but, because price is unchanged, they do not affect consumer surplus. However, fixed cost reductions can lead to increased consumer surplus indirectly, by making entry of marginal firms viable. Increased consumer substitution toward these new entrants can lower θ, which lowers price. Alternatively, entrants may fill an otherwise unserved niche in product space that better aligns consumer preferences with product attributes for some consumers. Either effect would represent increased allocative efficiency.

The product price is only a portion of the full price paid by consumers. In addition, consumers may incur non-trivial transactions costs including search, delivery and financial costs. The full price, P^F, equals the product price, P, plus transactions costs TC. Combining this with equation (1), we get:

$$P_I^F = \left(\frac{\theta_I}{\theta_I + 1} \right) MC_I + TC_I \qquad \textbf{(2)}$$

where *I* denotes Internet retailers.

Differences in the operations of an Internet retailer relative to a B&M retailer can affect any or all of marginal costs, fixed costs, seller substitutability, and transactions costs. First, many products that are shipped across state lines will avoid sales taxes. For some product categories, such as consumer electronics, this can represent substantial savings. However, since sales most supermarket items are not taxed, or are taxed at low rates, differences in tax treatments is not likely to greatly affect consumer choices.

Second, online retailers must deliver the order to the consumer. This represents a shift of some transactions costs from the consumer to marginal costs of the retailer. The total effect on the full price, P^F, could be either positive or negative and will depend on retailer strategy and particular consumer shopping patterns. For example, since national Internet only grocers' selection is often limited to nonperishable goods, many of their customers will not reduce the number of trips to the supermarket if they still wish to select perishable items. However, some consumers are already splitting their food purchases between one stores for pantry items and higher end grocers for perishable items (Morganosky, 1997). These consumers may reduce their store visits and their concomitant transactions costs.

Third, online retailers must gather the items for a customer's order. While Internet retailers incur these costs, customers no longer do. Again, these costs are shifted from consumers' transactions costs to retailers marginal costs. And again, the full price, P^F, could fall or rise. The amount of the transactions cost savings depends on the opportunity cost of consumer's time. Likewise, the marginal costs could be lower for national Internet only grocers because they can 'pick' from a warehouse

tailored to this sort of order fulfillment, while hybrid stores often 'pick' from B&M retail shelves.

Fourth, operating online can affect of fixed costs because retailers must develop a web presence and because a particular retailer facility can serve a more households in a geographic market. The cost of maintaining the web storefront represents a cost borne by online retailers, but not by B&M retailers. Also, where a B&M and hybrid stores primarily serve only a few neighborhoods in a city, national Internet only stores can serve all customers served by their delivery company. This can allow for economies of scale in inventory management and order fulfillment.

Fifth, ease of information gathering online could increase the substitutability between online retailers. With lower search costs, consumers typically choose to become better informed about alternatives and consider these alternatives better options (Ward and Arango, 1998, and Arango, 1999). If so, competition among Internet retailers should be more vigorous, O is smaller, and profit-maximizing price should be closer to marginal costs. However, this effect is not likely to be as large for groceries as it is for books and music (Brynjolfsson and Smith, 1999) or pharmaceuticals (Lee, 2000). This is because grocery consumers typically simultaneously purchase multiple items, some of which will be more or less expensive than if purchased from an alternative retailer. Search is not only computationally more complex, but also provides fewer savings on the market basket.

Recent research suggests that increased product information may not always translate into increased consumer price sensitivity online (Lynch, J. and Ariely, 1998, Degeratu, Rangaswamy, and Wu, 1999, and Shankar, Rangaswamy, and Pusatari, 1999). However, because these markets are so new, it is likely that the customer base for these online markets includes a disproportionate number of consumers who value convenience over price. If so, these results may not hold up as a more broad

consumer base develops.

Sixth, consumer switching costs could be lower online than with B&M stores. This too, would tend to make competition more vigorous, reduce θ, and drive prices closer to marginal costs. However, once again, switching costs for groceries are not likely to fall as much as they would for other products commonly marketed online. This is again due to the market basket nature typical of grocery shopping. Human capital specific to an online retailer is developed that lowers future transactions costs associated with finding and choosing preferred items. Since much of this human capital is abandoned when a customer switches retailers, consumers are reluctant to switch.

Below, I attempt to compare online and B&M grocery prices to distinguish between these effects. Since many of these hypothesized effects have similar implications, I will not be able to distinguish between them with these data. Instead, I am constrained to analyzing the net effect of these different effects. Three types of tests are conducted aimed at distinguishing differences in product availability, price levels, and price dispersion.

III. Data Description

This study uses price data collected from 32 stores in eight cities in central Illinois and Indiana and from five Web sites on the Internet (see table 1). The cities were chosen because of their proximity to Champaign, Illinois (within 100 miles) and their similar populations and demographics (see table 2). The retailers were chosen to include supermarket chains and at least one super center or discounter per city (Cub Foods, Walmart, K-mart, Miejer). In one city, an independent supermarket was includeed in order to obtain four retailers per city. Five Internet retailers were chosen, two of which are affiliated

with B&M retailers (see table 3). These data consist of prices for twelve non-perishable products and eight perishable products (see table 4). These products were chosen because they span a number of different supermarket departments, are available from most stores and are usually frequently purchased. The nature of the sample suggests that care be taken when making generalizations beyond these cities, retailers and products.

Prices were sampled from four retailers in each of two cities and from all of the Internet retailers during the Wednesday, and sometimes Thursday, of every week for 32 weeks begining August, 1999 and ending March, 2000. All prices were collected from in-store visits from shelf labels. In adition to the product itself, the price of a generic equivalent product was also recorded if it was offerred. Some stores and some products were missed in certain weeks, bringing the possible sample size to 8,040 observations. In fact, because of product unavailability in many retailers, especially online retailers, only prices for 5,836 of these possible prices were available.

IV. Data Analysis and Results

Product Availability Are as many products available online as are available in B&M stores? To answer this question, I created an indicator variable equal to one if a valid price was available from a store for a product in a given week. Table 5 reports various cross-tabulations of this variable for B&M stores and online stores. In this sample, a valid price is significantly more likely to occur for B&M stores. This is true for both perishable and non-perishable goods, but is more pronounced for perishable goods. Further, the availability of products differs significantly across online stores. For example, schnucks.com was equally likely to carry a non-perishable good as the average B&M store

and was actually more likely to carry the perishable foods.

Are as many store brand products as available online as are available in B&M stores? It is not clear whether brand names are more or less important to consumers online (Degeratu, Rangaswamy, and Wu, 1999). For those products available at a store, I created a dummy variable indicating whether a store brand was available. Table 6 reports cross-tabulations of this indicator variable for B&M and online stores. On average, online stores are much less likely to carry store brand products. However, this is because the Internet only stores have none while the hybrid stores some. In fact, schnucks.com is no less likely to carry a store brand than the average B&M store. I also calculated the average price difference between name brand products and their store brand equivalents if the latter was available. The difference between online and B&M stores was not significant for both simple ANOVA tests and when products, time periods, and city were controlled for.

Price Levels Are prices lower on online? To test this hypothesis, I regressed the natural logarithm of price against a series of dummy variables controlling for city, time period, product and variables indicating the type of retailer. Four retailer types were adopted: Online Hybrid, Online Internet only, B&M super center and B&M Supermarket (the excluded category). Because heteroskedasticity was expected (see below), an Aitken estimator was employed. The results are summarized in table 7. These results indicate that online hybrid store prices may not be different from B&M supermarket prices, but that Internet only prices are significantly higher and super center prices are significantly lower. These results obtain even when perishables and super centers are excluded.

These results suggest that marginal costs are higher for Internet only retailers and lower for super centers. It does not necessarily follow that Internet only retailers are less efficient or that super

centers are more efficient. First, consumer transactions costs for online shopping are likely to be lower. Second, the quality of the shopping experience at the super centers could be lower. Finally, since none of the online grocers have yet broken even, it is not clear to what degree their prices reflect underlying costs.

Price Dispersion Are prices less disperse online? To test this hypothesis, I tested for heteroskedasticity in an OLS estimator of price levels. Specifically, I regressed the logarithm of price against a series of dummy variables controlling for city, time period, product and retailer type dummies. The logarithms of the squares of the residuals from this regression are then regressed against all explanatory variables from the first stage. This essentially a modified Glesjer test and is the second step of the Aitken estimator used above. The results, summarized in table 8, suggest that prices among Internet only sellers are less disperse than among other types of retailers.

This result is consistent with greater substitutability between retailers in this segment of the market. If lower consumer search or switching costs lead to greater consumer substitutability across retailers, firms ability to maintain prices above marginal costs will be diminished. Moreover, their ability to price discriminate by offering limited time specials will also be reduced (Varian, 1980, Hoskins and Rieffen, 1999). This would be reflected in less volatile average price movements.

V. Conclusion

There are theoretical reasons to believe that online markets could be more efficient than B&M markets. Despite this, this study provided little evidence that online grocery markets are more economically efficient than traditional markets. Online markets tend to offer fewer items and fewer

store brand versions of the items they do carry. Prices for Internet only grocers are significantly higher than B&M supermarkets. These may be offset by reductions in some consumers' transactions costs. However, this may be true only for consumers with the highest opportunity cost of time, suggesting that online retailing will only be viable serving a niche market. Inferences from price differences must be tempered by the fact that super center food prices tend to be significantly lower than supermarket prices, yet supermarkets remain viable. Finally, that online price dispersion may be lower, suggests that retailers have less market power and that these markets are more efficient at allocating goods.

With online grocery retailing online in its infancy, predictions about the future from current behaviors could be misleading. With that caveat, these results suggest some implications for industry evolution. While online book and music retailers are often less expensive than B&M retailers, it seems that the Internet only grocers are not competing on price with supermarkets, let alone with the super centers. Therefore, it seems unlikely that they will have the mass appeal that online book and music retailers have achieved. In contrast, the hybrid retailers seem to fair better. For customers in a more limited geographic market, they appear to provide more products, more cheaply than online only grocers. It is unclear if this strategy is profitable since it may cannibalize B&M sales and it may undermine price discrimination strategies of B&M stores (Bailey, 1998).

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Table 1
Cities and Retailers in the Sample

Champaign-Urbana	Decatur	Bloomington	Springfield	Danville	Kankakee	Terre Haute	Peoria
Schnucks	Schnucks	Schnucks	Schnucks				
County Market				County Market		County Market	
	Eagle		Eagle	Eagle	Eagle		Eagle
	Kroger	Kroger			Kroger	Kroger	Kroger
		Jewel	Jewel	Jewel	Jewel		
							Thompson
	Cub Foods	Cub Foods	Cub Foods				Cub Foods
K-mart					K-mart	K-mart	
				Wal-mart		Wal-mart	
Meijer							

Table 2
City Demographics Information

City	Population	County	Median Household Income
Springfield	117,098	Sangamon County	$37,351
Decatur	79,972	Macon County	$34,800
Terre Haute	53,355	Vigo County	$30,403
Danville	31,761	Vermillion County	$29,542
Peoria	111,148	Peoria County	$36,596
Bloomington	58,841	McLean County	$43,207
Champaign/Urbana	99,152	Champaign County	$33,947
Kankakee	54,571	Kankakee County	$35,334

Table 3
Online Retailers

	'Brick & Mortor' Affiliation
www.peapod.com	Jewel
www.netgrocer.com	
www.groceronline.com	
www.moreonline.com	
www.schnucks.com	Schnucks

Table 4
Products in the Sample

	Description	Brand	Average Price
Perishables			
Bananas	1 lb		$0.496
Tomatoes	Cluster		$1.343
Lettuce	Iceberg, one head		$1.019
Hamburger meat	1 lb, ground chuck		$2.025
Cheddar cheese	16 oz, American	Kraft	$3.724
Orange juice	Frozen, 12 oz.	Minute Maid	$1.507
Corn	Frozen, 16 oz.	Birdseye	$1.467
Ice cream	64 oz, vanilla	Edy's	$4.431
Non-Perishables			
Salad dressing	Ranch, 16 oz.	Kraft	$2.720
Canned tuna	6.5 oz, water	Starkist	$0.753
Coffee	34.5 oz., F. Roast	Maxwell House	$7.758
Corn flakes	18 oz	Kellogg's	$2.738
Soup	10.75, Veg. Beef	Campbell's	$1.047
Canned peas	15 oz, sugar peas	Del Monte	$0.721
Canned tomatoes	28 oz, whole	Hunt's	$1.393
Canned peaches	15 oz, Rasp. Fl.	Del Monte	$1.086
Pasta	16 oz, elbow	Creamette	$1.012
Olive oil	34 oz, extra light	Bertolli	$8.344
Baby food	4 oz, apple sauce (2)	Gerber	$0.457
Cookies	20 oz.	Oreo	$3.369

Table 5
Availability of Products

	Non-Perishable Goods			Perishable Goods		
Type of Retailer	Invalid Price	Valid Price	Total	Invalid Price	Valid Price	Total
B&M Retailer	425	2,551	2,976	209	1,775	1,984
Online Retailer	628	1,220	1,848	942	290	1,232
Total	1,053	3,771	4,824	1,151	2,065	3,216
	Pearson P^2 statistic for differences across cells is 259.3 which is significant at the 1% level			Pearson P^2 statistic for differences across cells is 1437.5 which is significant at the 1% level		

Online Retailer	Invalid Price	Valid Price	Total	Invalid Price	Valid Price	Total
groceronline	213	135	348	231	1	232
moreonline	105	267	372	248	0	248
netgrocer	49	323	372	248	0	248
peapod	191	181	372	199	49	248
schnucks.com	70	314	384	16	240	256
Total	628	1,220	1,848	942	290	1,232
	Pearson P^2 statistic for differences across cells is 284.7 which is significant at the 1% level			Pearson P^2 statistic for differences across cells is 924.7 which is significant at the 1% level		

Table 6
Availability of Store Brands

	Store Brand Available	No Store Brand Available	Total
B&M Retailer	2,323	2,003	4,326
Online Retailer	296	1,214	1,510
Total	2,619	3,217	5,836
	Pearson P^2 statistic for differences across cells is 526.0 which is significant at the 1% level		
groceronline	0	136	136
moreonline	0	267	267
netgrocer	0	323	323
peapod	37	193	230
schnucks.com	259	295	554
Total	296	1,214	1,510
	Pearson P^2 statistic for differences across cells is 437.9 which is significant at the 1% level		

Table 7
Log Price Level Regressions

	All Products & All Stores	Non-Perishables & All Stores	Non-Perishables Excluding Super Centers
31 Week Dummies	(sign. 1%)	(sign. 10%)	(sign. 10%)
8 City Dummies	(sign. 1%)	(sign. 1%)	(sign. 1%)
19 Product Dummies	(sign. 1%)		
11 Product Dummies		(sign. 1%)	(sign. 1%)
Online Hybrid Dummy	0.012 (0.015)	0.027 (0.017)	0.038+ (0.018)
Online Internet Only Dummy	0.146* (0.016)	0.159* (0.016)	0.174* (0.017)
Super Center Dummy	-0.135* (0.007)	-0.162* (0.008)	
Observations	5,836	3,771	3,058
R^2	0.9330	0.9516	0.9526

Asterisks and plus signs denote statistical significance at the 1% and 10% levels. F-tests for dummy variables for week, city and product effects are usually indicate that they are significantly different from zero at a high confidence level. An Aitken estimator was used to control for heteroskedasticity.

Table 8
Log of Square of Price Residual Regressions

	All Products & All Stores	Non-Perishables & All Stores	Non-Perishables Excluding Super Center
31 Week Dummies	(not sign.)	(sign. 10%)	(not sign.)
8 City Dummies	(sign. 1%)	(sign. 1%)	(sign. 1%)
19 Product Dummies	(sign. 1%)		
11 Product Dummies		(sign. 1%)	(sign. 1%)
Online Hybrid Dummy	-0.046 (0.170)	-0.064 (0.202)	-0.314 (0.207)
Online Internet Only Dummy	-0.327+ (0.172)	-0.257 (0.193)	-0.565* (0.199)
Super Center Dummy	0.034 (0.074)	-0.089 (0.095)	
Observations	5,836	3,771	3,058
R^2	0.0741	0.0736	0.0870

Asterisks and plus signs denote statistical significance at the 1% and 10% levels. F-tests for dummy variables for week, city and product effects are usually indicate that they are significantly different from zero at a high confidence level.